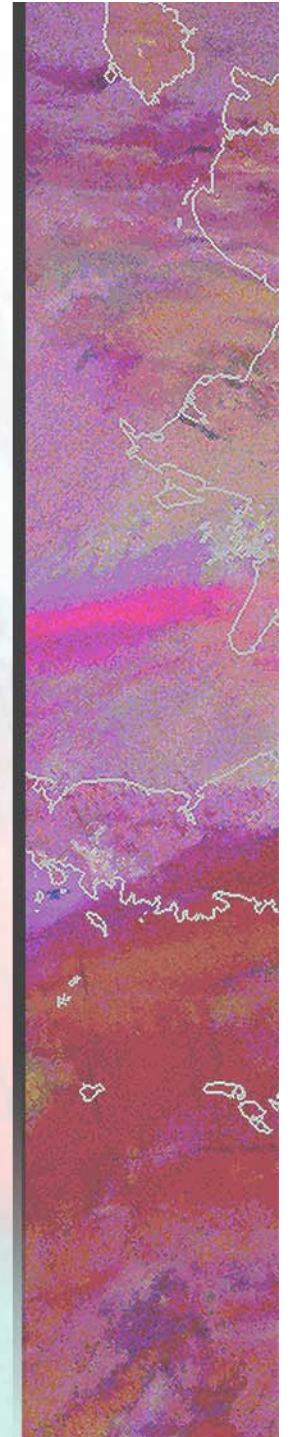
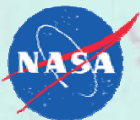


A Gridded CrIS/ATMS Visualization for Operational Forecasting

Bradley Zavodsky, Nadia Smith, Jack Dostalek, Eric Stevens, Kristine Nelson, Elisabeth Weisz, **Emily Berndt**, William Line, Chris Barnett, Antonia Gambacorta, Tony Reale, and David Hoes

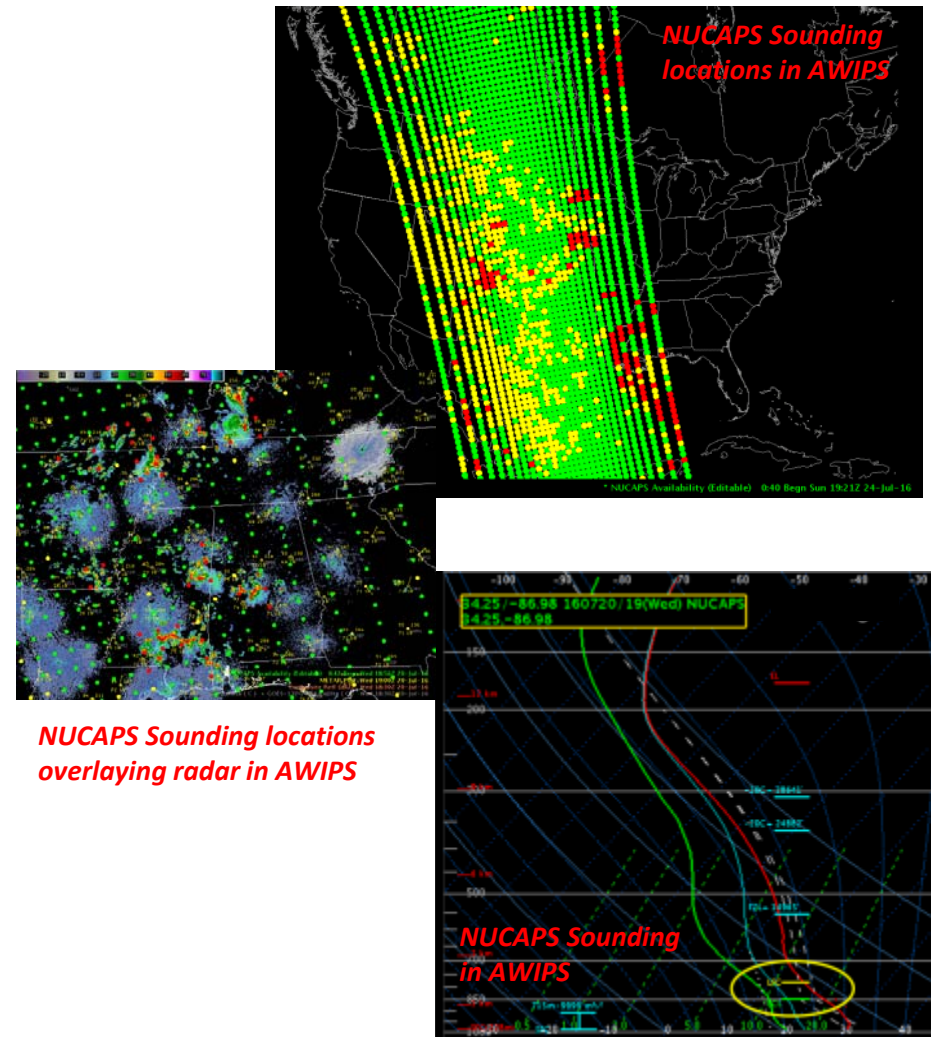
28th Conference on Weather Analysis and Forecasting / 24th Conference on Numerical Weather Prediction at the 97th American Meteorological Society Annual Meeting

25 January 2017



Current Operational NUCAPS Visualization

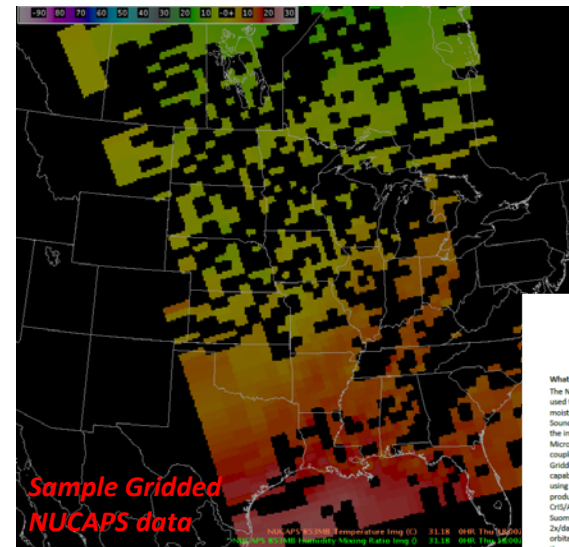
- NUCAPS is the NOAA Operational Retrieval algorithm for CrIS/ATMS and IASI/AMSU T and q profiles
- Capabilities for displaying individual Skew-T plots are available in the latest versions of AWIPS II with quality control flags
- Skew-Ts are valuable for some forecast challenges, but ***visualizing the data in plan view or cross section may be more useful for others***
- Multi-organization group—started through NUCAPS Initiative—has been funded by JPSS PG/RR to demonstrate these capabilities with NWS forecasters



Images by Kris White (NWS
HUN/NASA SPoRT)

Gridded NUCAPS for Demonstration

- CIMSS has modified its polar2grid software package to include readers for NUCAPS
- SPoRT obtains Direct Broadcast data, runs polar2grid, and converts output to gridded binary (GRIB2) format for ingest into AWIPS II
- GRIB2 files are pushed to NWS partners in real-time
- CIRA obtains the GRIB2 output and creates graphics for its website that can be linked by forecasters in public statements
- Team has developed training and quick guides that leverage foundational NUCAPS training



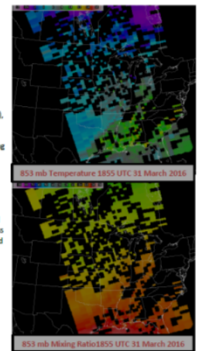
Sample Gridded NUCAPS data

Gridded NUCAPS Quick Guide



Gridded NUCAPS Retrievals Quick Guide by NASA/SPoRT

What is Gridded NUCAPS and when is it available?
The NOAA Unique NUCAPS Processing System (NUCAPS) is used to derive atmospheric profiles of temperature and moisture using observations from the Cross-track Infrared Sounder (CRIS)—a hyperspectral sounder with 1305 channels in the infrared and near-infrared—and the Advanced Technology Microwave Sounder (ATMS)—a microwave sounder which is coupled with the infrared to allow for cloud clearing. The Gridded NUCAPS product is complementary to the Skew-T capabilities already integrated into AWIPS (NUCAPS Availability), using the same data and retrieval algorithm. Each pixel in the product represents a single field of regard for the combined CRIS/ATMS product. CRIS and ATMS are aboard the polar-orbiting Suomi NPP spacecraft, so NUCAPS retrievals are available 2x/day, valid approximately 1:30 AM & PM locally (light daily orbital variation) with a latency of only 40 minutes to 1 hour through use of Direct Broadcast data.

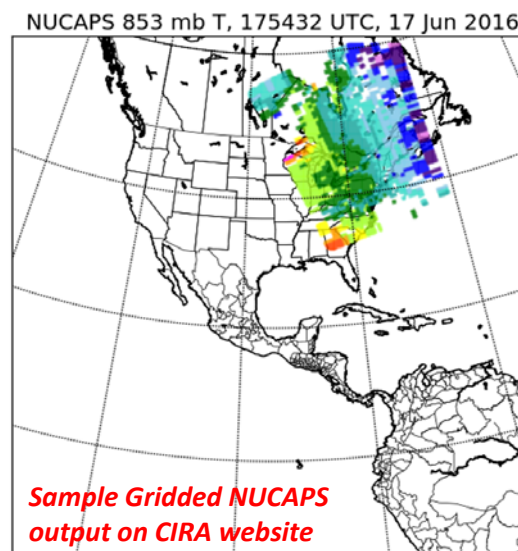


Caveats
Clouds interfere with the infrared energy measured by CRIS and result in missing values; therefore, missing data will occur across the swath in areas that are not clear. When viewing the gridded NUCAPS retrievals, only the highest quality retrievals that include both the microwave and infrared components of the retrieval will be displayed. Gaps in the data correspond to the locations of the yellow and red dots in the NUCAPS Availability product. To reduce gaps across the swath, future product development may include quality control adjustment to also display retrievals that have small quality error (i.e., yellow dots in NUCAPS Availability) based on forecaster feedback.

Why are Gridded NUCAPS Retrievals Important?

This demonstration product was created to allow forecasters the ability to view satellite derived temperature and moisture in plan view in addition to Skew-Ts. While understanding the vertical structure at point locations is important, a regional perspective of isotropic temperature (top figure) and moisture (middle figure) can aid in identifying patterns at different vertical levels that impact stability in the pre-convective environment. For example, rather than searching many Skew-Ts for the extent of low-level moisture, the plan view product can give a snapshot of where this moisture patterns have set up. Although, there are gaps in the afternoon pass in the examples, the product demonstrates the capability to analyze pre-convective temperature and moisture characteristics on 31 March 2016, prior to severe weather in the central and southern U.S. (left figure). With a 1:30 pm local time orbit pass, NUCAPS can provide additional observations of the pre-convective environment, especially if retrievals with both good and high quality were displayed. Future capabilities will include cross-section analysis across the swath and the ability to view derived stability parameters.

Last Modified April 2016

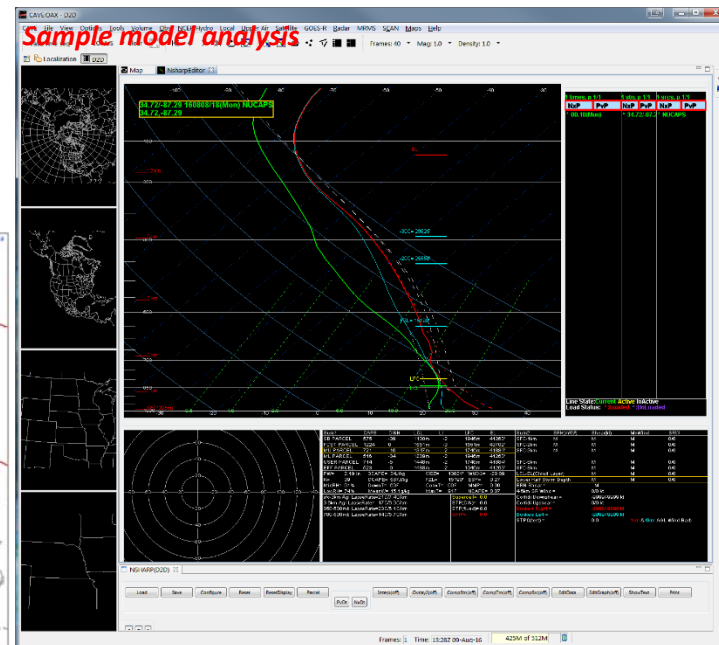
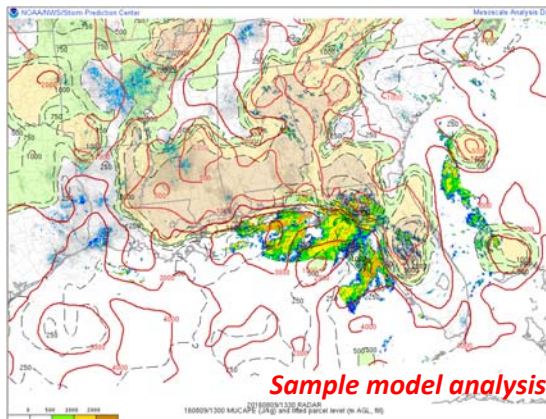
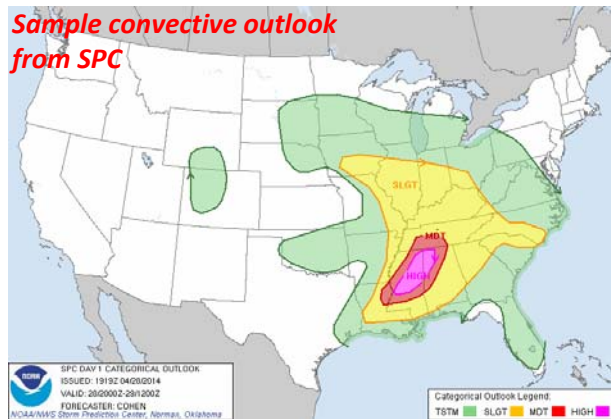


Sample Gridded NUCAPS output on CIRA website

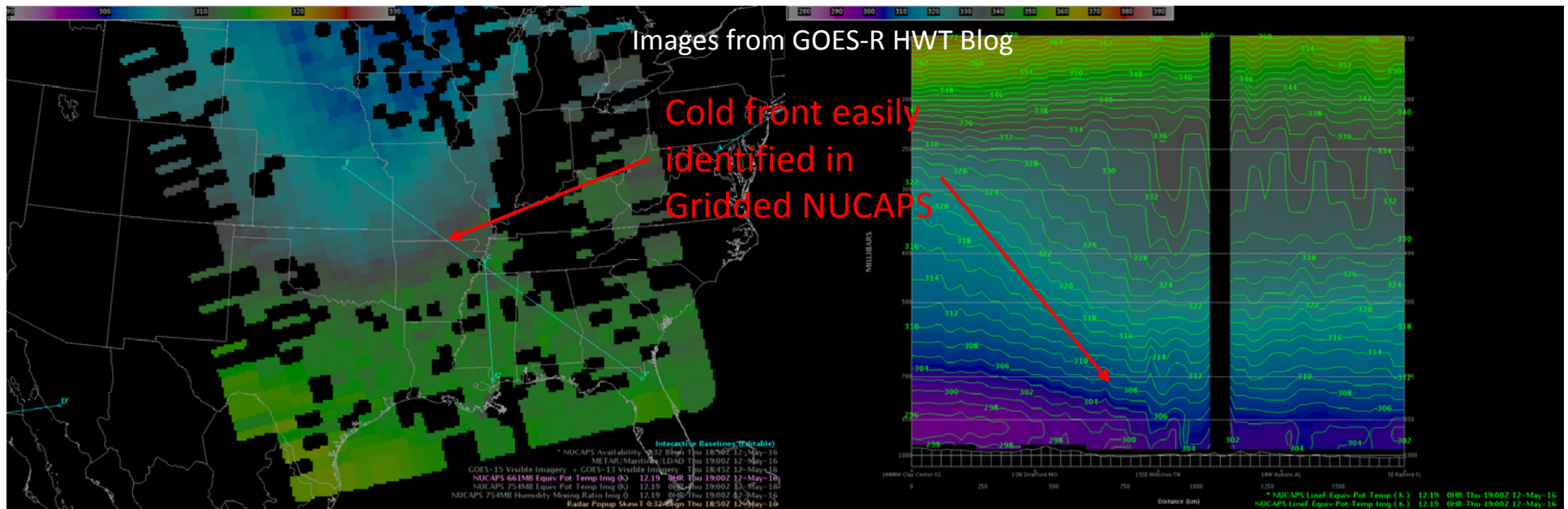
Forecast Challenge: Diagnosing Convective Environment

- The vertical distribution of temperature and moisture in the lower atmosphere determines convective potential
- Forecasters use a combination of in situ observations, satellite data, and models to determine the location of boundaries and areas of instability
- Ability to view plan view and cross sections of NUCAPS data in a beta version were demonstrated at the 2016 Hazardous Weather Testbed Experimental Warning Program
- Next slides detail feedback from forecasters at HWT on utility of Gridded NUCAPS products

Sample convective outlook from SPC

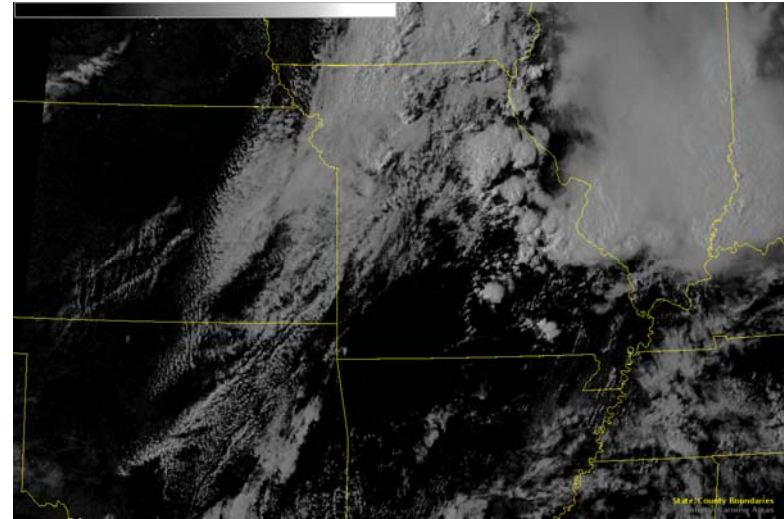
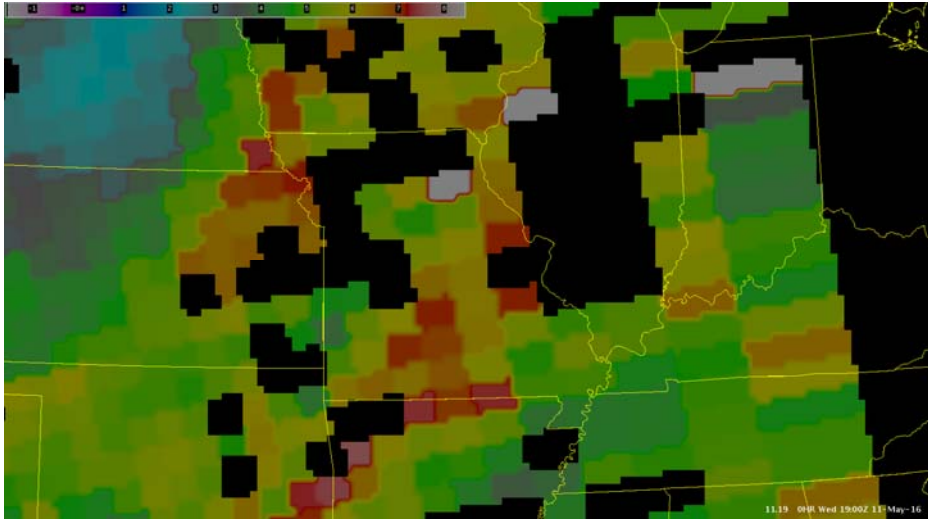


Gridded NUCAPS Convection Application



“We recently gained the ability to create cross sections through the NUCAPS swaths. This will be helpful for diagnosing phenomena such as boundaries and convective instability. The first image below is a plan view display of theta-e at 660 mb across the region. Obvious is the much cooler, drier air behind the cold front (low theta-e) with moist, warmer air ahead of it to the east (high theta-e). Also plotted is a line, denoting the location for which the cross-section (image below) was taken, through the cold front. The cross-section depicts theta-e vertically through the atmosphere. This provides another perspective on the cold front, which is obvious in the image.”

Gridded NUCAPS Convection Application



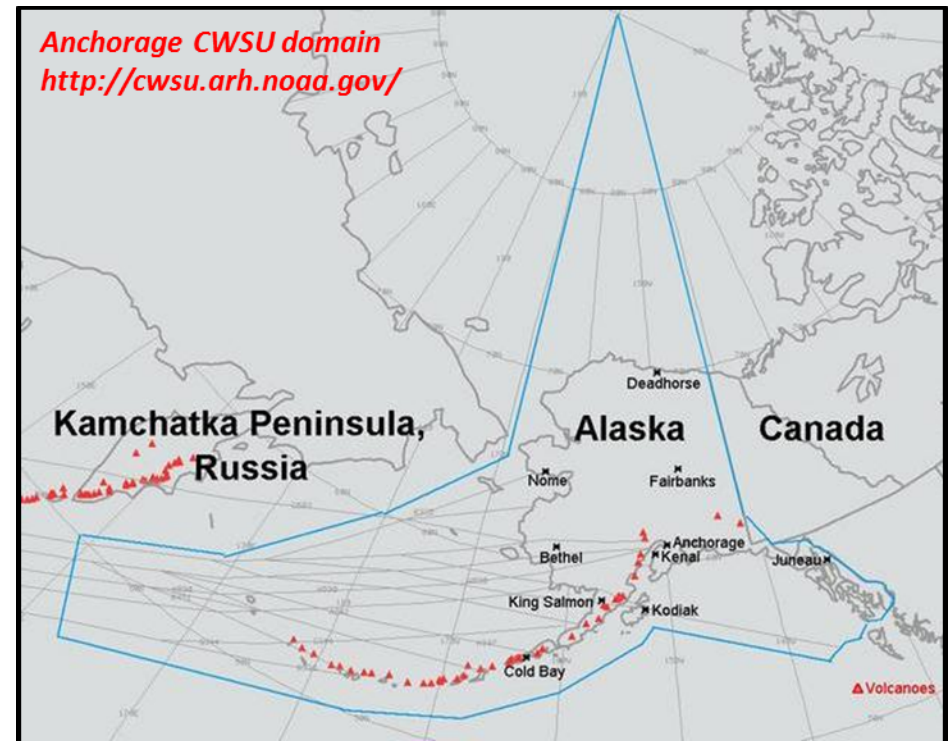
Images from GOES-R HWT Blog

“We took a look at a NUCAPS plan view image of mid-level moisture (754 mb mixing ratio) from 19Z. Image shown below. Areas of higher moisture were apparent over south-central Missouri in our SGF CWA, and over the St. Louis metro area.

Several hours later, we noted that convective activity was focused in these general areas. The few cells that developed over our CWA were over the south-central part of the state. Much more significant convection triggered over the St. Louis area. –JP”

Forecast Challenge: Cold Air Aloft

- Cold Air Aloft ($\leq -65^{\circ}\text{C}$) can lead to freezing airliner fuel and regularly occur at flight levels in the arctic
- Center Weather Service Units (CWSU) provide Meteorological Impact Statements (MIS) to Air Traffic Controllers to direct flights around the 3D air features
- In data sparse Alaska, forecasters have relied on analysis and model fields and limited radiosonde observations to guess the 3D extent of the Cold Air Aloft
- Use of satellite observations provides an opportunity for forecasters to observe the 3D extent of the Cold Air Aloft in real-time where conventional observations are lacking



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FAAK20 KZAN 121458  
ZAN MIS 01 VALD 121500-130300  
...FOR ATC PLANNING PURPOSES ONLY...  
COLD AIR ALOFT  
FROM 185NE SCC-65NE ORT-55SW ENN-110NW BRW-185NE SCC  
TEMPS -65C OR LESS FM FL350-400. AREA MOVG NE 40 KTS.  
CMW NOV 14
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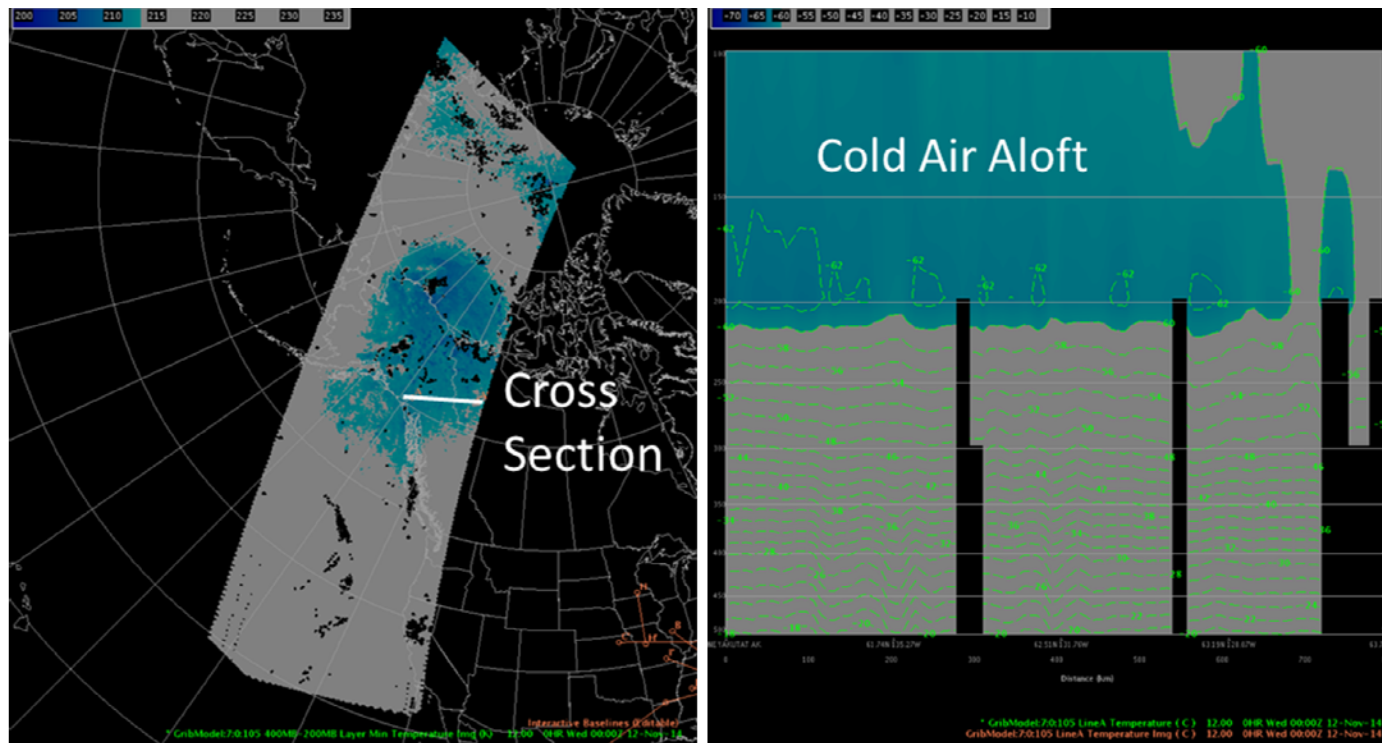
Lat/Lon Extent of Cold
Air from soundings,
aircraft reports, model

Vertical Extent of Cold Air from
soundings/aircraft reports/model

Motion determined
from model data

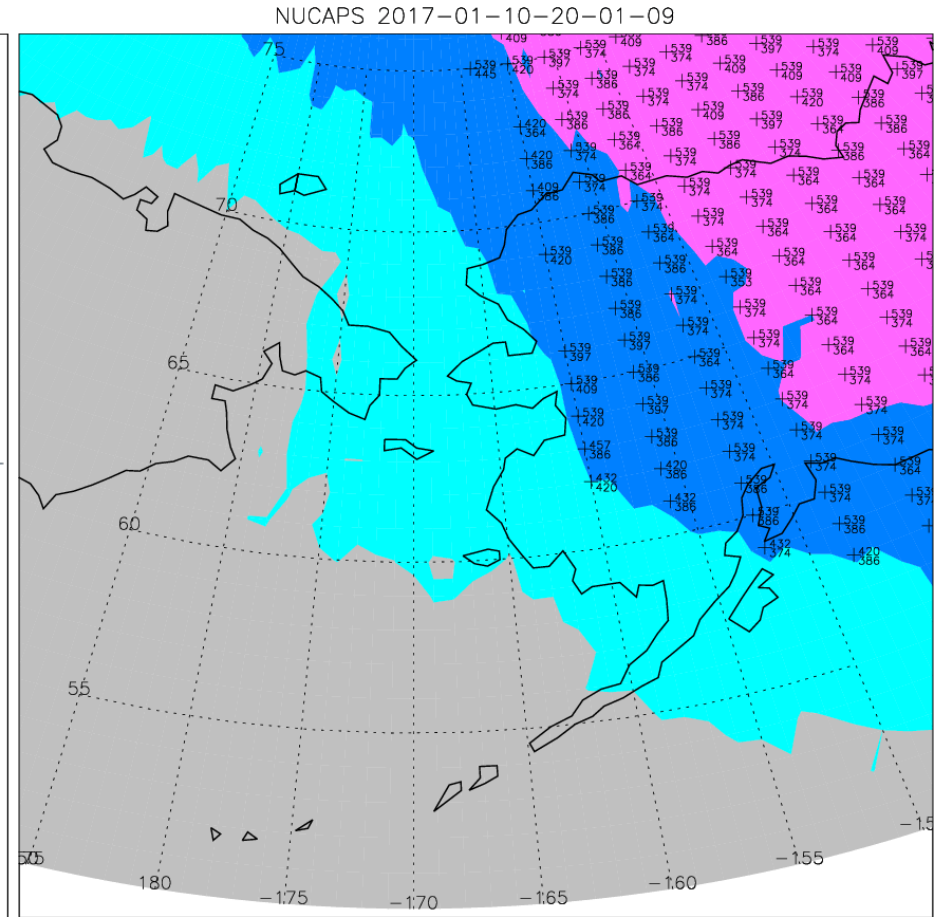
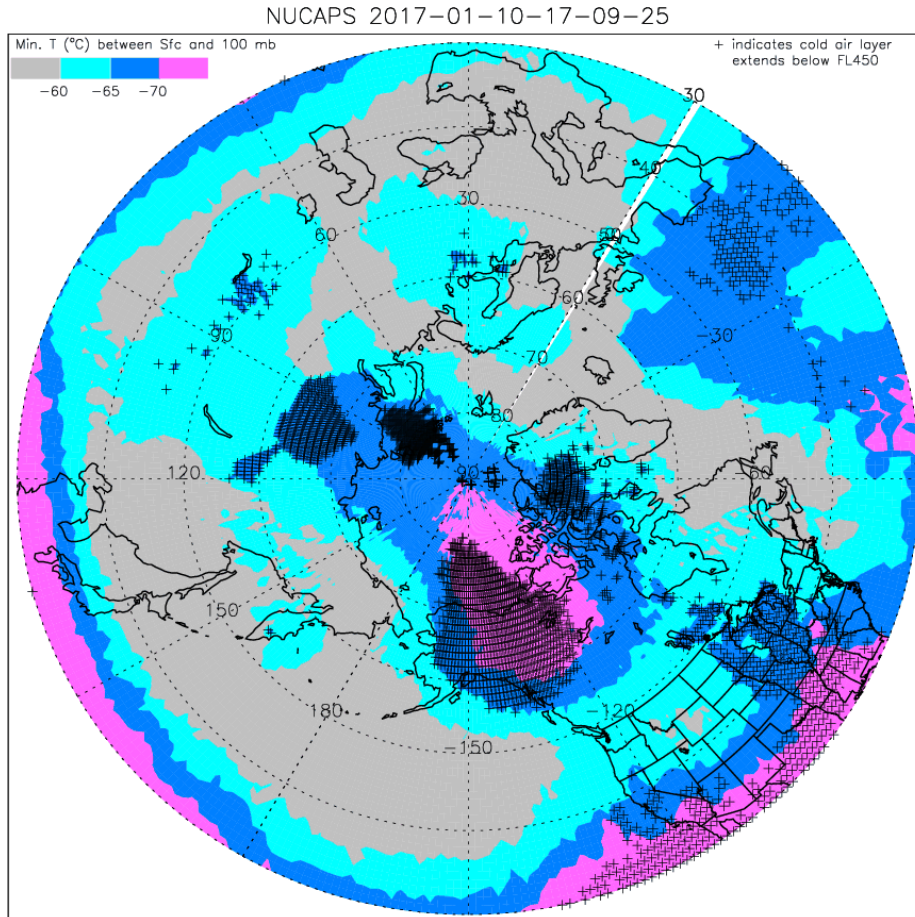
AWIPS Visualization of Cold Air Aloft

- Developed specific visualization color curve and AWIPS procedures to outline the coldest air and allow forecasters to easily toggle between pressure levels
- Light blue shading for temperatures anywhere below 100 hPa in the column that are $< -60^{\circ}\text{C}$
 - Darker blue shading for temperatures anywhere below 100 hPa in the column that are $< -65^{\circ}\text{C}$
- Forecasters at Alaska WFOs and CWSU now have access to this visualization in their operational AWIPS systems for ongoing demonstration



AWIPS Visualization on Web

- As part of this project, CIRA has integrated NUCAPS soundings as part of their Cold Air Aloft web portal where images of the total column data are shown
- 10 January 2017 case shown here is a CAA event where Alaska CWSU where forecasters determined very large impact of the NUCAPS data for giving additional confidence in model output



Summary and Next Steps

- A collaborative project between CIRA, CIMSS, GINA, NOAA/NESDIS, STC Inc., and SPoRT has developed a unique visualization for the CrIS/ATMS NUCAPS soundings for forecast challenges, including convective potential and cold air aloft
- Product demonstrations occurred in Spring 2016 at the HWT and ongoing at the AK CWSU have yielded positive forecaster feedback and have also provided ideas for making incremental changes to the product to make it more useful in operations
- Plan to participate in next HWT Spring Experiment with more robust training on using the gridded products
- Working with the AWIPS Development community to develop gridding capabilities internal to AWIPS source code that will use NUCAPS files already coming over the Satellite Broadcast Network (SBN) directly into NWS offices to reduce data flow and provide full transition of capability into operations

Acknowledgements

This project is funded by the NOAA Joint Polar Satellite System Proving Ground/Risk Reduction Program, directed by Dr. Mitch Goldberg. We would also like to thank the forecasters from the Alaska Center Weather Service Unit (CWSU), Alaska Aviation Weather Unit (AAWU), and participants of the 2016 HWT for their time and effort in providing feedback on the Gridded NUCAPS products.

Any questions?

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